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BETTER PLANNING AND MANAGEMENT OF THREAT SIMULATORS AND
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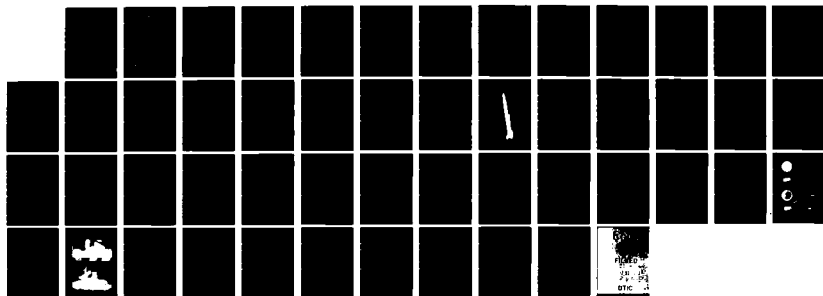
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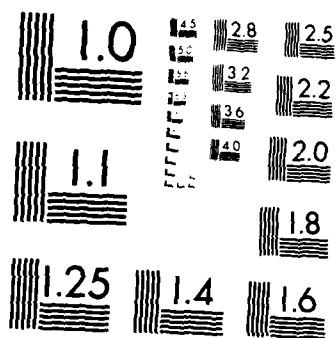
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BY THE COMPTROLLER GENERAL

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ADA 129851

Report To The Congress

OF THE UNITED STATES

Better Planning And Management Of Threat Simulators And Aerial Targets Is Crucial To Effective Weapon Systems Performance

Operational test and evaluation is the most effective way, under peacetime conditions, to determine a weapon system's combat worth. Realistic testing, however, requires test resources, such as threat simulators and aerial targets, that duplicate, to the extent possible, the characteristics of the enemy's weapon systems.

DOD's test resource planning practices, organizational structures, management emphasis, and intelligence support for threat simulators and aerial targets can be improved to provide better assurance that current and future weapon systems will meet performance expectations.

GAO recommends several actions to improve DOD's planning and management of critical test resources. GAO also recommends that the Congress monitor DOD's progress in resolving the problems identified in this report.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report addresses the Department of Defense's capability to test its weapon systems and recommends actions that will improve the completeness and adequacy of weapon testing. This report focuses on testing against two of the more significant threats to the military services--the newer Soviet aircraft and missile systems and the Soviet's considerable capabilities in electronic warfare.

We are sending copies of this report to the Secretary of Defense and to the Director, Office of Management and Budget.

Charles A. Bowsher
Comptroller General
of the United States



A

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

BETTER PLANNING AND MANAGEMENT
OF THREAT SIMULATORS AND AERIAL
TARGETS IS CRUCIAL TO EFFECTIVE
WEAPON SYSTEMS PERFORMANCE

D I G E S T

Under peacetime conditions, operational testing in a realistic environment against equipment that simulates the enemy's weapons continues to be the most credible demonstration of the combat worth of our weapon systems. All three military services, however, are unable to test, to the extent possible, many of their weapon systems in a representative combat environment. This is because development of electronic warfare threat simulators and aerial targets have not kept pace with the deployment of the enemy's weapons. For example, the United States' inventory of threat simulators does not cover many of the enemy's weapon systems that our weapons may face. Some threat systems, such as certain radar jammers, have no simulator coverage at all.

As a result of the shortfalls, important weapons--such as the Navy's Aegis cruiser and improved Phoenix air-to-air missiles, the Army's Patriot missile system, and the Air Force's new B-52 offensive avionics system, will be deployed without having fully demonstrated their capabilities under representative combat conditions. The DOD has recognized the importance of electronic warfare threat simulators and aerial targets and has described overcoming the deficiencies as challenges. (See ch. 2.)

Test resources include facilities, equipment, and personnel. In this review GAO focused on two types--electronic warfare threat simulators and aerial targets. GAO concentrated on these two resources because of their importance in demonstrating weapon system performance and because of congressional concern over the ability of weapon systems to meet their intended missions. (See pp. 2 and 3.)

GAO found that shortcomings in electronic warfare threat simulators and aerial targets were primarily caused by problems in four areas. These areas are

- test resource planning,
- organizational structures,
- management emphasis, and
- intelligence support.

GAO found that the problems in planning and management emphasis are not limited to threat simulators and aerial targets, but also cause problems in other test resources. (See ch. 3.)

Resolving issues in these four areas will not necessarily solve all of the problems. For example, legitimate safety and environmental concerns restrict the use of certain test resources and thereby constrain realistic testing. However, as addressed below, GAO believes improvements in planning, organization, management emphasis, and intelligence support will ultimately result in better tested and thus, more effective weapons for our fighting forces. (See pp. 6 and 13.)

TEST RESOURCE PLANNING

Early and detailed test planning is needed to allow (1) timely identification of test resource needs, (2) time necessary for developing needed resources, and (3) disclosure of critical testing issues so that risks can be sufficiently identified to decisionmakers. This planning is now done through test and evaluation master plans prepared by the weapon systems developer and the operational test agency.

GAO's review of selected weapon systems and the Department of Defense (DOD) studies show that test and evaluation master plans have not been detailed or timely and, therefore, have not provided the test resource developer with sufficient information or time to ensure that test equipment is available when weapon systems are ready for testing. For example, the EF-111A tactical jamming system test requirements were made known to the test facility only 4 months before testing was

to begin. The facility did not have the necessary resources and could not obtain them in time. Consequently, only limited testing was accomplished. (See p. 14.)

ORGANIZATIONAL STRUCTURES

GAO found that known organizational problems continue to exist in the Air Force and the Navy and are impeding the acquisition of electronic warfare and aerial target test resources. The Army, however, has corrected its organizational problems through reorganization. The Navy's organization for electronic warfare, as an example of inappropriate organization, is fragmented with 11 different types of Navy command organizations having overlapping responsibilities in electronic warfare testing.

These organizational arrangements often force weapon developers to choose, for example, between delaying the development of a missile or the threat simulator used to evaluate the effectiveness of that missile. In one case, a Navy office that develops electronic warfare equipment also develops the equipment used to test and evaluate the combat effectiveness of the electronic warfare devices. Similarly, the Air Force's Firebolt aerial target is under the same management structure as weapons such as the Advanced Medium Range Air-to-Air Missile and thus competes for funds, priority, and personnel. While these trade-offs between weapon systems and test resources may be necessary, they should be made at service headquarters levels as they are in the Army, where a broader view of total force requirements can be applied. (See p. 16.)

MANAGEMENT EMPHASIS

GAO believes that insufficient support for testing and test resources within the DOD weapon development community is contributing to inadequate and, in some cases, nonexistent test resources. Important test resources such as the Firebolt aerial target and electronic warfare threat simulators have not been adequately funded because top management, in many cases, lacks the commitment necessary to ensure the timely development of test resources. Many internal service studies have carried this message. For example, in a review of the adequacy

of electronic warfare test capability, a 1982 Air Force study stated that electronic warfare test resource capability improvements have not been available when needed, primarily because the improvements have not been funded. Discussions with top service and the Office of the Secretary of Defense (OSD) officials corroborate the studies. For example, the former Director of the Navy's Electronic Warfare Division stated the emphasis is on deploying systems first and then testing them. (See p. 19.)

INTELLIGENCE SUPPORT

GAO found that several threat simulators have been developed using inaccurate and incomplete intelligence data. Testing weapons with non-representative threat simulators further adds to the problems of achieving realism in testing and reduces confidence in the accuracy and usefulness of the test results.

The Defense Audit Service and other DOD agencies have also reviewed intelligence support to test and evaluation; each has found, as GAO did, significant problems. The identified problems range from intelligence data being too sensitive to disseminate, to inappropriate assignment of data analysis responsibilities by the Defense Intelligence Agency. GAO believes, however, that most of the recommendations in the DOD studies do not adequately address the underlying causes of what is generally perceived as poor intelligence support to test and evaluation. GAO also believes that further evaluation by DOD is necessary to better define the problems and develop appropriate solutions. (See p. 21.)

EFFORTS TO IMPROVE TEST CAPABILITIES

Recent DOD initiatives to improve test capabilities are encouraging. The Under Secretary of Defense, Research and Engineering, in a fiscal year 1984 budget statement to the Congress, discussed threat simulator and aerial target deficiencies and characterized them as challenges. In addition, the Army has reorganized its threat simulator development program; the Navy has recognized its fragmented management of electronic warfare; the Air Force is making

changes in its fragmented management structure; and OSD has alerted its top management to the threat simulator problems. Most of these efforts, however, identify problem areas but do not offer definite plans for corrective action. GAO is encouraged by these latest efforts, but recognizes that they are first steps and should be followed by definitive action plans. (See pp. 1, 17, 18, 19, and 23.)

AGENCY COMMENTS

Representatives of OSD, the Army, Navy, and Air Force orally commented on a draft of this report. They were primarily concerned that GAO had over generalized its findings rather than limiting them to electronic warfare threat simulators and aerial targets. In those instances where GAO's findings, conclusions, and recommendations apply only to electronic warfare threat simulators and aerial targets, GAO changed the report accordingly. However, since this and prior GAO reports show that shortcomings in planning and management emphasis apply generally to testing and test resources, GAO believes changes in these areas are not necessary. (See p. 24.)

Overall, DOD believes that its testing program and test resources are adequate. DOD states further that it is committed to a continuing, sound test resources program. DOD also stated that GAO's constructive suggestions in threat simulator and aerial target test resources are welcome and that DOD will continue to emphasize those areas. (See p. 25.)

DOD disagreed, however, with GAO's findings regarding the completeness of testing, the Air Force's management of aerial targets and threat simulators, and inadequate intelligence support to the test community. (See p. 26.)

DOD also disagreed with GAO's proposals to strengthen and enforce the test planning process as well as to closely review the issues surrounding intelligence support to test and evaluation. In general, DOD stated that their existing practices and policies address the

problems identified by GAO. However, GAO pointed out that its findings showed that these efforts have not been fully effective and further actions are needed. In addition, the Secretary of Defense, in his fiscal year 1984 budget statement to the Congress recognized that deficiencies exist in threat simulators and aerial targets and called for a program to improve the realism in testing. (See pp. 24 to 26.)

RECOMMENDATIONS TO THE SECRETARY OF DEFENSE

To improve the planning and management of critical test resources, GAO recommends that the Secretary of Defense:

- Take several actions to improve the timeliness, completeness, and usefulness of the Test and Evaluation Master Plans.
(See p. 26.)
- Improve the Navy's and the Air Force's organizations for developing threat simulators and aerial targets by transferring acquisition responsibility to a service organization with the independence, authority, responsibility, and funds to ensure successful development of test resources.
(See p. 26.)
- Initiate a review of intelligence support to identify the underlying causes and to solve the problems of inadequate support to the threat simulator development community.
(See p. 26.)

Because of the magnitude of threat simulator and aerial target shortfalls, GAO believes there is an immediate need for a DOD-wide program to improve the situation. GAO therefore, also recommends that the Secretary of Defense establish a joint-service threat simulator and aerial target improvement program to prioritize, time phase, and resolve DOD-wide test resource problems. (See p. 26.)

RECOMMENDATION TO THE CONGRESS

This report shows that major weapon systems are being deployed without the best possible demonstration of their capabilities under combat type conditions. DOD has been giving the Congress reports on the cost, schedule, and performance status of its major weapon systems since 1969. Additionally, annual hearings on weapon systems have continually highlighted weapon performance issues and the need for better test and evaluation, as have many GAO reports. Nevertheless, the problems associated with inadequate and incomplete testing continue.

Since improvements in test resources will lead to better testing and thus, to better weapon system performance, GAO recommends the Congress monitor DOD's implementation of (1) the joint-service aerial target and electronic warfare test resource improvement program and (2) the separation of test resource and weapon system acquisition management in the Navy and the Air Force. (See p. 27.)

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ABBREVIATIONS

AMRAAM	Advanced Medium Range Air-to-Air Missile
DOD	Department of Defense
GAO	General Accounting Office
OSD	Office of the Secretary of Defense
TEMP	Test and Evaluation Master Plan

CHAPTER 1

INTRODUCTION

Test and evaluation of weapon systems is accomplished throughout the acquisition process to identify and reduce development risks and to ensure that a weapon system will perform as intended. The Department of Defense (DOD) decisionmakers and the Congress use the results to manage and oversee the development and acquisition process. In fact, DOD's acquisition policy states that successful accomplishment of test and evaluation is a key requirement for decisions committing significant resources to a program or to advance it from one acquisition phase to another. Operational test and evaluation is especially important because it demonstrates whether a weapon system will perform as intended. The increasing sophistication and capabilities of DOD's new weapon systems make testing even more critical to ensure that expensive weapons achieve the best performance possible.

This report discusses DOD's capability to perform necessary test and evaluation in support of the need for high quality weapon system performance data. The report focuses on two types of test resources ¹/--electronic warfare threat simulators and aerial targets. It also discusses actions necessary to improve DOD's capability to support testing.

The importance of aerial targets and electronic warfare threat simulators was underscored by the Under Secretary of Defense, Research and Engineering, when, in his fiscal year 1984 statement to the Congress (March 2, 1983), he cited these two areas as challenges and recognized that deficiencies exist in both threat simulators and aerial targets. Specifically, he called for a coherent, coordinated program to provide a realistic threat environment for testing all major systems. He also indicated that various alternatives for a target to represent the low altitude, high speed, surface ship missile threat are under evaluation.

¹/Test resources are those resources necessary to conduct test and evaluation of weapon systems and include such things as data processing equipment, telemetry and other communications devices, support vehicles, aerial targets, and electronic warfare threat simulators.

TESTING IN AN ELECTRONIC WARFARE ENVIRONMENT IS BECOMING MORE IMPORTANT

Admiral Thomas Moorer (former Chief of Naval Operations, U.S. Navy) has said, "If there is a World War III, the winner will be the side that can best control and manage the electromagnetic spectrum." This statement emphasizes concisely, the significance of electronic warfare and underlines the importance of testing weapon systems in a realistic electronic warfare environment.

Electronic warfare involves the use of electromagnetic energy (i.e., radio waves) to determine, exploit, reduce, or prevent the enemy's use of the electromagnetic spectrum. Electronic warfare affects all electronic systems, including radars, navigation systems, communications, and guidance systems. In fact, almost everything the military uses can be severely degraded in an electronic warfare environment. A discussion of electronic warfare principles is in Appendix I.

The enemy will use electronic warfare as a weapon with a specific mission--its doctrine advocates the use of electronic warfare as an element of combat power. For this reason, all weapons subject to degradation by electronic warfare should be tested in as realistic and stringent an environment as possible. Battlefield commanders have to know the full capabilities and limits of their weapon systems. Recent experiences in the Falklands conflict and especially Israel's successes against Syria's surface-to-air missile systems underscore the importance of complete and accurate weapon system performance information.

DEVELOPMENT OF SUITABLE AERIAL TARGETS IS BECOMING MORE DIFFICULT

Realistic operational test and evaluation of weapon systems requires aerial targets that test weapon systems as they are used in combat. Since it is not practical to use actual enemy aircraft and missiles as targets, DOD designs and develops targets that are intended to represent the critical capabilities and characteristics (speed, altitude, electronic countermeasures, engine heat patterns, and etc.) of enemy aircraft and missiles.

Newer enemy weapons, such as the Foxbat aircraft and the low altitude, supersonic antiship missiles, present difficult challenges to target developers. As technology pushes weapon systems' capabilities to new heights, the target developer tries to match that capability with low-cost vehicles that can be effectively used in testing and training. Target development is an increasingly important task, since significant weapon performance limitations may go undetected unless aerial target development keeps pace.

OUR PREVIOUS REPORTS HAVE DISCLOSED SIGNIFICANT TESTING ISSUES

We have issued numerous reports on DOD's test and evaluation process. As early as 1972, we reported that most systems did not have adequate test plans and that testing was not accomplished in a timely manner. In 1975 we reported that the most troublesome problem in test resources was the lack of realistic targets. Other reports on the testing function and our annual weapon system reports have also stressed the need for improved realism in testing and more representative test resources. A list of our reports involving testing is in Appendix II. As this report shows, significant improvements have been made in some areas, but many improvements still need to be made. (See ch. 3.)

THE CONGRESS HAS BECOME INCREASINGLY CONCERNED ABOUT TESTING AND WEAPON SYSTEM PERFORMANCE

The Congress has consistently taken an interest in the planning, conduct, evaluation, and reporting of test results. In 1971 the Congress passed Public Law 92-156, requiring DOD to provide the Congress with data, through congressional data sheets, on the operational testing and evaluation of its weapon systems. As early as 1969, DOD has been giving the Congress quarterly reports on the cost, schedule, and performance status of its major weapon systems. Annual hearings on weapon systems have continually highlighted weapon performance issues and the need for better test and evaluation. In addition, the House Committee on Government Operations and the Senate Committee on Governmental Affairs plan to hold hearings during the summer of 1983 on the role of testing and test resources in weapon system acquisition.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our primary objective was to assess DOD's capability to test and evaluate its weapon systems in an electronic warfare environment and against aerial targets that represent the expected threat. We met the objective through two means. First, we reviewed and updated internal DOD studies and assessments and our prior reports on testing and test resources. Second, we reviewed the management and use of electronic warfare and aerial target test resources in several DOD weapon system testing programs. Our fieldwork was conducted from April through December 1982.

We reviewed prior studies to determine whether DOD had reported any problem areas concerning the adequacy of test resources and to acquire historical information. We used information gained from the studies in our review of selected weapon system test programs. Whenever we used information from prior DOD studies or our reports, we determined whether or not the condition reported still existed and whether any corrective actions had been taken.

To complement and update the historical information provided by previous studies, we used nine DOD weapon system testing programs as a means to illustrate the current state of DOD's management and use of test resources in general and electronic warfare threat simulators and aerial targets specifically. We selected 9 of 88 weapons that either had been or would be tested during fiscal years 1982 and 1983. The test programs (listed below) were chosen to serve as examples to illustrate the overall problems in the management and use of test resources. We believe these systems represent a broad range in terms of missions and capabilities. Time and other constraints prevented us from selecting additional programs. During our review, however, we became aware of problems encountered in other weapon systems and have included them where appropriate.

Test Programs Reviewed

<u>Army</u>	<u>Navy</u>	<u>Air Force</u>
Single Channel	High Speed Anti-	B-52 Offensive
Ground-Airborne	Radiation Missile	Avionics System
Radio System-VHF	ALQ-126B Defensive	F-16 Multinational
Tactical Communications	Electronic	Staged Improvement
Jamming System	Countermeasures	Program
Patriot Missile System	Set	EF-111A Tactical
	Phoenix AIM-54C	Jamming System
	Missile	

A description of each weapon system is contained in Appendix III.

By comparing test plans with test reports and interviewing cognizant officials, we determined how test resource needs were identified and fulfilled. We also determined, through reviewing documents and interviewing test officials, how test resources were used and how test resource limitations were treated in test reports and other related documents.

By comparing the test plans and reports with descriptions of available test resources, we identified discrepancies between those test resources needed and those available. The nature and extent of the discrepancies, as well as the effect on test adequacy, was obtained through interviews with test officials and reviews of pertinent documents.

We made no attempt to assess the effectiveness of either a weapon system or its program management; nor did we assess the overall adequacy of a weapon's test program. Consequently, no conclusions can be reached regarding the overall management of a particular weapon system on test program.

We did our review at the services' operational test and evaluation agencies, selected test ranges, operational commands, weapon system program offices, the Office of the Secretary of

Defense (OSD), and service headquarters offices. Additionally, we contacted selected defense contractors and related defense associations. A complete list of locations visited is in Appendix IV.

Our review was made in accordance with generally accepted government auditing standards.

CHAPTER 2

THE TEST RESOURCE PROBLEM TODAY

Without test resources that adequately duplicate the characteristics of the threat, the true performance capabilities of DOD's weapon systems will not be known, and significant risks may go unexposed until deployment and actual use. For example, the Air Force's Sparrow air-to-air missile was tested against aerial targets that did not realistically represent the actual threat. When first used in Vietnam, the Sparrow missed its target more often than it hit it. The Sparrow's effectiveness improved after further operational test and evaluation and subsequent design modifications.

DOD's policy ^{1/} requires operational test and evaluation to be accomplished in an environment as operationally realistic as possible, using test resources that closely resemble the expected wartime and peacetime conditions. A realistic environment is especially necessary when testing weapons that may be used against Soviet aircraft and missiles and when testing in an electronic warfare environment.

The development of realistic electronic warfare threat simulators and aerial targets has not kept pace with the increasing complexity and performance levels of weapon systems used by our adversaries. As a result, DOD's weapon systems are being tested in environments that do not adequately represent the conditions in which the weapons are expected to perform. Important and costly weapons, such as the Navy's CG-47 Aegis cruiser, the improved Phoenix air-to-air missile, the Army's Patriot missile system, and the Air Force's B-52 offensive avionics system, will be deployed without assurance that they will meet performance expectations.

PRACTICAL CONSTRAINTS ON TESTING

A totally realistic operational environment is difficult to achieve and, therefore, operational testing cannot always be as realistic as it should. Practical limitations, such as range size or nearness to population centers, may limit the use of test resources and the weapons being tested. High powered jammers, for example, may not be used near other communications equipment. In addition, under certain circumstances, long-range missiles or targets cannot be flown over populated areas. These considerations and others will always be limiting factors on realistic testing, but improvements can still be made in the management and development of test resources that will lead to more realistic testing and better system performance.

^{1/}DOD Directive 5000.3, Test and Evaluation, December 26, 1979.

LIMITED ELECTRONIC WARFARE TEST CAPABILITIES

The realism of the test environment directly affects the validity of test results. Typically, however, most environments at test ranges and facilities do not adequately approximate the real threat because electronic warfare threat simulators are not available in sufficient quality, numbers, or types.

A 1982 study sponsored by OSD reported that the number of simulators needed clearly exceeds anticipated resources: Of 84 test programs scheduled between fiscal years 1982 and 1987, at least 60 may face threat simulator shortfalls.

The United States inventory of threat simulators does not cover many of the enemy's weapon systems that our weapons may face. As the following chart illustrates, some threat systems have no simulator coverage at all.

Coverage of Potential Threat Systems With Existing United States Simulator Resources (as of 1981)

<u>Type of threat</u>	<u>Percent simulated</u>
Early warning/ground controlled intercept radars	34
Surface-to-air missile radars	61
Antiaircraft artillery radars	60
Airborne intercept radars	27
Infrared systems	50
Ground-based jammers	14
Shipborne jammers	0
Airborne jammers	0

Source: Derived from a comparison of data contained in the Threat Simulator Master Plan, OSD/Director, Defense Test and Evaluation, February 1982.

Other service studies have identified additional problems with threat simulators and our audit work showed that they continue to exist. Some of these problems are discussed below.

A 1978 Naval Audit Service report on naval electronic warfare capabilities revealed major deficiencies in the Navy's ability to test and evaluate its weapon systems in an electronic warfare environment. The report identified lack of visibility at higher management levels, inadequate funding and planning, and fragmented management as the basic causes. Further, the Navy's current Electronic Warfare Master Plan, prepared in 1981, recognized several problems. The plan indicated an overall lack of simulation equipment to generate an adequate operational environment for either testing or training.

The Army, in its Mission Element Need Statement for the Army Development and Acquisition of Threat Simulators program, stated that a satisfactory realistic threat environment for testing cannot be provided. A 1982 study sponsored by OSD said that most range environments cannot approximate the real threat because the requisite number and types of simulators are not available. The report attributed the nonavailability of threat simulators to a variety of circumstances, including insufficient funding, intelligence gaps, and incomplete correlation of program requirements with acquisition plans.

The Air Force, in a 1982 evaluation of electronic warfare test capabilities, concluded that present threat simulator capabilities cannot support known and projected test requirements. Further, the differences between existing and required test capabilities were reported to be increasing, because of

- a rapid increase in the number of threat systems,
- the time required to obtain sufficient intelligence data on the threat systems,
- the lead times necessary to build or modify test systems and ranges, and
- threat simulator budget limitations.

The limitations identified in these studies have led to a number of significant shortcomings in the testing of several weapon systems. The Navy, for example, cannot fully assess the performance of several of its systems in an operational environment because of the lack of suitable simulators. Some simulators have not been developed while others do not adequately represent the threat they are designed to simulate.

The Air Force's new offensive avionics system for the B-52 experienced similar shortcomings in threat simulator availability. Not all of the test resources (simulators of enemy radar jammers) necessary to obtain sufficient assurance of operational effectiveness were available. The test manager was not satisfied that the system could successfully counter the

threat and recommended further testing with analytical simulations and computer models. According to the test manager, however, simulations and computer models to support recommendations contained in the test report are not available. Consequently, the performance of the system in its operational environment cannot be adequately assessed.

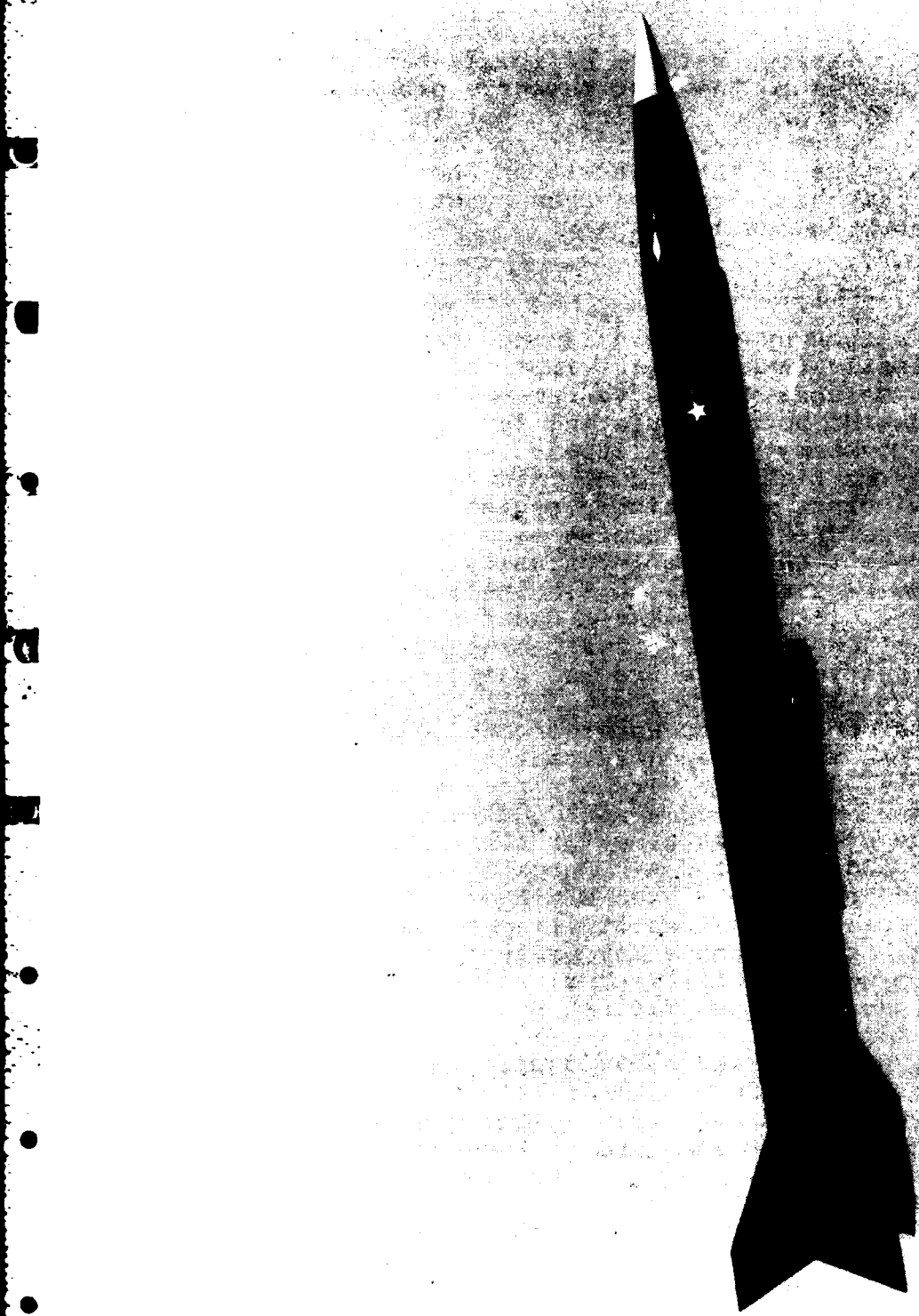
Discussions with various service officials have surfaced other contributing causes to the test resource problems. Some suggested that many military commanders do not fully appreciate the intricacies of electronic warfare or its potentially devastating effects. The recent emphasis on shortening weapon system acquisition time has also been seen by others as conflicting with thorough testing.

LIMITED AERIAL TARGET CAPABILITIES

Several major weapon systems--including the Advanced Medium Range Air-to-Air Missile (AMRAAM), the improved Phoenix missile, and the Patriot Air Defense Missile System--will be fielded without complete testing because existing aerial targets cannot adequately test the systems' capabilities. An urgent need exists for targets that can realistically duplicate the high altitude, high speed threat aircraft and antiship cruise missiles, and the low altitude, high speed antiship cruise missiles. The Air Force's planned Firebolt target may eventually satisfy the high speed, high altitude requirements, but limitations in other areas--its small size, its nonrealistic radar and infrared signatures, and its lack of an electronic countermeasures capability--will significantly reduce its usefulness.

The Firebolt is scheduled to enter production in 1985, after the testing of several major weapon systems has been completed. The Army, for example, needs the Firebolt target to evaluate the Patriot against a high speed/high altitude threat. However, the Firebolt will not be produced in time for testing with the Patriot system. In addition, the Air Force's AMRAAM will not be realistically tested against the high altitude, high speed threat before production because the Firebolt will not be ready in time. Consequently, these weapons may be approved for production with unknown performance capabilities or the production decision could be delayed because of insufficient performance data.

No existing target can reasonably duplicate the threat posed by the sea-skimming supersonic cruise missile. The Navy's Firebrand was to have filled this void but it was cancelled by the Navy because it could not adequately represent the threat and was not cost effective. As a replacement, the Navy is planning to modify an existing target (the Vandal) as a short-term solution. The Vandal, however, will not adequately duplicate the sea-skimming cruise missile. For the long term, the Navy plans to develop a supersonic low-altitude target. The Vandal is



Courtesy U.S. Airforce

U.S. Air Force Firebolt Aerial Target

FIGURE 1

scheduled to be available shortly, but a supersonic low-altitude target will not be available until much later. As a result, the U.S.S. Ticonderoga equipped with the Aegis fleet air defense system will be deployed without demonstrating an ability to defeat a supersonic sea-skimming cruise missile.

Delays in developing the Firebolt and the cancellation of the Firebrand have forced the services to rely on segmented testing using a "family of targets" approach. The current "family," however, includes the same targets with the same major limitations that the Firebolt and the Firebrand were to overcome. An April 1981 study sponsored by OSD stated that no existing aerial target can satisfy all minimum testing needs in the areas of speed, altitude, maneuverability, endurance, scoring, and radar and infrared signatures. Air Force officials responsible for developing aerial targets stated that these limitations still exist, are restricting testing, and are critical to successful test and evaluation.

The Air Force Inspector General, in a 1979 report, concluded that aerial targets had low priority and visibility at higher management levels and sufficient funding had not been programmed, although the using commands demonstrated a need for the targets. These factors still exist and significantly contributed to delaying deployment of the Air Force's Firebolt target system. Originally planned for 1981, deployment is now scheduled for 1985.

The Inspector General's report also surfaced an important issue that underlies many of the problems affecting all test resources. The report pointed out that the Air Force aerial targets program is formally managed as a weapon system and contends for attention and first level trade-offs with weapon systems such as the F-15, air intercept missiles, and the Low-Altitude Airfield Attack System. Conversely, target users view aerial targets as test and evaluation and training devices. The report stated that aerial targets are of little use in and to themselves and, therefore, should neither be considered nor formally managed as weapon systems.

CONCLUSIONS

Although the services have recognized the inability of existing electronic warfare threat simulators and aerial targets to adequately meet present and future test requirements, their efforts to resolve the problems have not been successful. Threat simulators used in testing weapons in electronic warfare environments are limited in both quality and quantity. In a number of cases, no simulators exist or are planned for threats that have been in existence for years. Furthermore, the services still lack sufficient aerial targets to assess the performance of weapon systems against the enemy's increasingly sophisticated systems.

Numerous studies demonstrate that the problems are well known and, more importantly, persistent. Several of the studies suggest the problems are, at least partially, due to a lack of agreement within DOD on the importance of threat simulators and aerial targets. The Air Force has pointed to the management of targets with weapons and the resultant trade-offs between F-15s and targets. Other studies have suggested that military commanders do not fully appreciate the devastating effects electronic warfare can have on a weapon's effectiveness. Still others have pointed to the inherent conflict between thorough testing and DOD's current emphasis to accelerate weapon system acquisition time. Consequently, electronic warfare testing and aerial targets have received limited resources and have not kept pace with the weapon systems that need them for thorough testing.

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In Chapter 3, the underlying causes of limitations in DOD's test capability are examined. Solutions which we believe will greatly improve the service's efforts to eliminate these limitations are also provided.

CHAPTER 3

RESOLVING TEST RESOURCE PROBLEMS FOR THE FUTURE

Designing and developing suitable test resources to realistically simulate enemy weapons is very difficult, and test resource developers must overcome many obstacles. In some areas, such as the acquisition of precise miss-distance indicators for aerial targets, technology has delayed development. In other instances, the need to protect intelligence data and sources has restricted the development and use of certain enemy electronic warfare equipment simulators. Even when test resources are developed, other factors may limit their use. High powered jammers, for example, cannot be used near civilian communications equipment.

Many reasons delay or, in rare instances, prevent the timely development, acquisition, and use of threat simulators and aerial targets. Four areas, however, are so pervasive they affect almost every threat simulator and target development program. These areas, basic to any well organized endeavor, are

- planning,
- organization,
- management emphasis, and
- intelligence support.

Successful accomplishment of these functions, fundamental to good management, will remove some of the most serious obstacles to satisfactory threat simulator and aerial target development. Until development programs are properly planned, better organized, given adequate management emphasis, and obtain sufficient intelligence support, it is a virtual certainty that needed resources will not be available when weapons are tested. In addition, we believe the problems in planning and management emphasis are systemic and adversely affect testing and test resources in general.

As Chapter 2 demonstrated, there are severe shortages in the number and types of electronic warfare threat simulators and in realistic aerial targets. As a result, DOD is fielding weapon systems without sufficient knowledge of their ability to survive or function in combat. Field commanders are operating weapons with unknown, perhaps dangerous, limitations.

EARLY TEST PLANNING IS CRUCIAL TO SUCCESSFUL TESTING AND EVALUATION

Test planning, when accomplished early and in sufficient detail, has several purposes. It

- allows early identification of needed test resources and gives test resource developers time to design and develop required resources;
- anticipates potential testing issues early enough to be resolved before testing starts; and
- allows management to make more informed decisions, including appropriate trade-offs among competing alternatives.

Current DOD policy and implementing service regulations require the weapon system developer and the operational test agency to begin detailed test planning before starting the demonstration/validation phase (Milestone I) of the acquisition process. These early test plans, called Test and Evaluation Master Plans (TEMPS), are to contain all of the basic elements necessary for the identification, development, and acquisition of test resources and require OSD approval. Specifically, the test plans are to contain

- a description of the weapon system to be tested;
- a discussion of the critical test and evaluation issues;
- an outline of the planned testing; and
- specific identification of key test resources, including equipment, personnel, and funds.

TEMPS--an underused keystone for early test planning

The importance of early test planning was emphasized by the Under Secretary, Defense Research and Engineering, in an August 9, 1982, memorandum to the services. He said that proper planning is essential to improving the acquisition process and that priority attention must be given to incorporating test requirements into established planning documents such as the TEMP. He further stated he intends to use TEMPS to "clearly identify test resource requirements."

Properly used, the TEMP can serve as the basic test document to define testing strategy and test resource needs. However, TEMPS have not been applied to their potential. We found cases

where TEMPs were either too late, incomplete, or both, to be satisfactorily used by decisionmakers.

For example, the TEMP on the EF-111A aircraft program did not, as required by current DOD guidance,

- specify the kinds of threat simulators needed,

- identify steps necessary to acquire needed simulators,
or

- identify expected test limitations and the adverse effects of those limitations.

The EF-111A test program had significant limitations that adversely affected the scope and completeness of the testing. The operational tests were limited to a single EF-111A, escorting four other aircraft, striking a target complex defended by only a handful of surveillance and tracking radars. Therefore, electronic signal density was significantly less than the expected combat environment and reduced the quality of the test data. In addition, the evaluation of the EF-111A's other support roles were limited by a scarcity of test resources. According to a 1982 Air Force study of electronic combat test capabilities, the shortages are continuing and will adversely affect the test and evaluation of the EF-111A's upgrade program. These testing limitations were known before testing and should have been surfaced in the early TEMPs so decisionmakers could assess the risks of incomplete testing.

The lack of early planning affected the EF-111A's testing in other ways. The Air Force Test and Evaluation Center presented its test resource requirements to a test facility only 4 months before testing was scheduled to begin. The facility stated it would need at least 7 months to acquire the necessary resources. Consequently, only limited testing was accomplished.

The B-52 offensive avionics program is another example that illustrates the problems of inadequate test planning and insufficient test resources. The program's TEMP did not specify the types of test resources needed, whether resources were available, or the effect of not having adequate resources. The B-52 could not be adequately tested against recognized threats because threat simulators were not available in sufficient quantity. Thus, the B-52's capability is not fully known. Again, these limitations should have been surfaced before testing began.

We attempted to quantify the problem of late and incomplete TEMPs but, because the necessary records were not available at DOD, were unable to accomplish this task. Other evidence, however, suggests the problem is widespread. Several service and

OSD officials responsible for reviewing and approving TEMPs complained of late and incomplete TEMPs. This view is corroborated by a 1981 study for the Defense Systems Management College. In their review of six weapon system test programs, four did not have TEMPs early enough to effect the adequacy of test and evaluation decisions. The problems are continuing; the Tomahawk cruise missile is in production but still does not have an OSD approved TEMP.

The Airborne Self-Protection Jammer program, on the other hand, is an example of where a TEMP has been properly prepared. It contains a comprehensive list of necessary test resources, including some that are not in DOD's inventory. These resources are identified as being critical to determining the combat effectiveness of the jammer.

We do not believe that by just enforcing the TEMP requirements, adequate test resources will be available. Indeed, we found examples where specific test resources were identified as not available and the resources were still not available when needed. The High Speed Anti-Radiation and Phoenix missiles had TEMPs that clearly identified specific targets but, because of other problems, the targets were never developed. However, without adequate planning test resource needs cannot be identified and acquisition programs cannot be started.

ORGANIZATIONAL STRUCTURES SHOULD NOT CREATE DEVELOPMENT BARRIERS

The Navy's and the Air Force's current organizational structures for developing threat simulators and aerial targets are fragmented with no clear assignment of management responsibility among the many organizations involved. In some cases, the structure allows direct competition between weapon systems and the test resources needed to evaluate them. To allow the same manager to control a weapon development program and the test resources used to evaluate the success of that weapon creates, in our opinion, a conflict of interest.

Navy threat simulator management-- fragmented with conflicting interests

Fragmented management

The Navy's management of threat simulator development is fragmented, with no single office in charge. This fragmentation impedes the Navy's efforts to acquire threat simulators because it diffuses responsibility and makes coordination and overall program direction difficult.

Problems with the Navy's current management of threat simulators are recognized by the Navy but little action has been

taken to correct them. A 1978 Naval Audit Service report stated that due to the lack of adequate planning and funding, as well as fragmented management, the Electronic Warfare Threat Environment Simulation Facility at the Naval Weapons Center "... does not have the prerequisite capabilities to perform its mission." (This facility is the Navy's primary electronic warfare test range.) A 1980 study by the Naval Air Systems Command identified the fundamental issue underlying many of the study's findings as fragmentation of management at both the Chief of Naval Operations and lower command levels, resulting in insufficient coordination, inadequate or duplicate requirements, inefficient support planning, and a lack of cost effectiveness in the acquisition, support, and use of threat simulators.

The Navy Electronic Warfare Master Plan, issued in 1981, also highlighted fragmented management. It identified 11 types of Navy organizations, ranging from the operational commands to the test and evaluation community, that have electronic warfare responsibilities. The report stated that the various organizations have overlapping structures and approach electronic warfare in terms of their own environment, motivations, and limitations. Within the Office of the Chief of Naval Operations, the Electronics Warfare Division is responsible for coordinating the acquisition of threat simulators, but has no funding or management authority. As the 1981 Electronic Warfare Master Plan points out, however, mere coordination, without resource control, is not enough. In spite of the previous studies, fragmented management of electronic warfare test resources continues within the Navy.

Conflicting interests

In at least one case, the Navy's organizational structure may have contributed to a lack of test capability at the Navy's primary electronic warfare test range.

The Naval Air System Command's program manager for airborne electronic warfare devices is also responsible for planning, budgeting, and acquiring simulators at the Navy's Electronic Warfare Threat Environment Simulation Facility. Thus, the same person is in charge of both developing electronic warfare equipment and controlling the development of the threat simulators necessary to test that equipment. Placing responsibility for both developing and testing weapon systems with one person or office results in conflicting interests and may result in a situation where several weapons could be funded at the expense of the equipment needed to determine the combat worth of those weapons. Although no direct connection can be made, the 1978 Naval Audit Service Report states the electronic warfare test facility does not have the resources to accomplish its mission. Our fieldwork also showed that the test facility continues to experience significant shortfalls in acquiring threat simula-

ors. We also note that of the 24 Navy test programs included in the 1982 Threat Simulator Master Plan, all will face threat simulator shortfalls.

Air Force test resource management--
also fragmented with conflicting interests

Air Force threat simulator and target development programs are also impeded by current organizational structures. No single focal point or "in-charge" office for threat simulators exists and the aerial target program is in direct competition with Air Force missiles for funds, priority, and personnel.

Threat simulators

A 1982 Air Force Systems Command study on electronic warfare test capability concluded that present threat simulator capabilities cannot support known and potential test requirements and that the gap is widening. It cited fragmented management and budget approval processes as two of the major causes. For example, in studying the Air Force Program Objective Memorandum review process, the Air Force found that program decision packages for threat simulator development are fragmented--no single program element includes all threat simulator requirements, and no single Air Staff review board reviews all test resource program elements. Consequently, no single organization or office controls the approval of threat simulator requirements. In addition, proposed threat simulators often must compete with proposed electronic warfare equipment within a single program element. This arrangement results in test equipment competing for funds with the weapon system it will be used against, similar to the situation in the Navy.

According to an Air Force threat simulator developer, the fragmentation of management and budget approval means there is no structured way to identify and coordinate threat simulator requirements. He added that the absence of a sound organizational structure has contributed to the current shortage of threat simulators.

Aerial targets

The Air Force's aerial targets program office is located in the Air Force Systems Command's Armament Division at Eglin Air Force Base, Florida. The program office is under the Deputy Commander for Counter-Air Systems who is also responsible for developing weapons such as the AMRAAM. This organizational arrangement places aerial targets in direct conflict with the weapons they will be used against in testing similar to the Navy's organizational arrangement discussed earlier.

The previously mentioned 1979 Air Force Inspector General report noted that targets were being formally managed as if they were weapon systems. As a result, the targets were susceptible to trade-offs with weapons such as the F-15 and air intercept missiles. The report also said this competitive structure does not allow a sufficient evaluation of the need for targets. A recommendation was made to transfer aerial targets from the counter-air mission area to the defense-wide management and support/test and evaluation support mission area, to more appropriately compete with other test and evaluation resources and not with weapon systems.

As recommended, aerial targets were transferred, but in June 1982, they were transferred back to the counter-air mission area to compete with higher priority weapon systems. In August 1982, the aerial targets program office lost 21 personnel to the AMRAAM program office because AMRAAM is a higher priority program. This action is the result of competition the Air Force Inspector General warned against in 1979.

Army management--single manager concept

The Army Development and Acquisition of Threat Simulators program was initiated in 1972 to develop threat simulators for the Army. In 1981, recognizing that significant deficiencies in the Army's capability to test in a realistic battlefield environment existed, several changes were made in the threat simulator program that are intended to improve its ability to develop and deploy realistic threat simulators. The changes

- tied threat simulator requirements to threat assessments rather than test plans and
- created a separate program element for threat simulators, reducing internal competition.

By generating threat simulator requirements from threat assessments instead of weapon system test plans, the Army does not rely on weapon system developers to provide threat simulator requirements. Further, creation of a separate program eliminates direct competition between threat simulators and weapon systems and allows trade-off decisions to be made at Army Headquarters level.

Although the Army's new organizational structure has not had time to prove itself, we believe it should result in a wider variety and better quality threat simulators that more accurately simulate a given threat. We further believe centralized control should result in decisions based on a broader view of force requirements and eliminate the inherent conflicting interests when weapon system developers choose between a weapon system and threat simulators.

MANAGEMENT EMPHASIS OF TESTING
AND TEST RESOURCES IS IMPORTANT

Although test resources are critical to the test and evaluation process, the amount of management emphasis received has not been commensurate with their importance. All too often, the test resource budget is cut when budgets are pared.

Priority and funding decisions for test resources begin in the early planning stages of weapon system test programs. At this point, needed test resources should be identified, their importance to the overall test and evaluation capability determined, and actions initiated to ensure that resources will be ready when needed. As we have seen, however, early planning does not always identify the necessary test resources or assess their importance to testing. Consequently, the resources do not receive the management support necessary to ensure their timely development.

Even after development programs are begun, organizational structures make test resources easy candidates for budget reductions and schedule delays. The Air Force's Firebolt aerial target program is a good example. The target program is under the same management as weapons such as the AMRAAM and is constantly competing for funds and priority with these weapons. Although the Firebolt is needed to support the testing programs of many weapons, the Air Force deferred all fiscal year 1984 production funding and did not budget production funds for fiscal year 1985. Instead, the priority and funding were given to the missile program. At the insistence of OSD, the Air Force has restored the fiscal year 1985 production funding.

Electronic warfare threat simulators have similar problems. According to a 1982 Air Force study, test capability improvements are not available when needed, primarily because of insufficient funding. The study cited many previous studies that identified threat simulator problems and made recommendations for improvements which were under consideration at the time our audit work was completed. A major finding of the current study, however, was that past studies' recommendations were not implemented. We believe a lack of adequate priority prevented implementation of the recommendations.

According to Navy test representatives, many of the Navy's threat simulator deficiencies have also been known for years, yet the Navy has taken few actions to correct the deficiencies. For example, a review by the Naval Audit Service in 1978 found that the Navy could only conduct limited test and evaluation of its airborne electronic warfare equipment because it lacked adequate test resources. The audit report recommended several actions to upgrade test resource limitations, and the Chief of Naval Operations agreed. Almost 5 years later, however, the Navy has yet to approve and implement a plan to correct the deficiencies.

Several top service officials also share our concern over the general lack of support given testing and test resources. The Director of the Navy's Office of Research, Development, Test, and Evaluation, for example, has stated that weapon developers generally do not want to fund test resources and will use funds that were earmarked for test resources for other things. He said the attitude of nonsupport for testing starts at the OSD level. The philosophy seems to be "testing is delaying things--design it and produce it--reduce testing." Further, the Navy's former Director of Electronic Warfare told us that he believes the services should field weapon systems as they are built and fix them later through preplanned product improvement programs. This strategy, however, was designed to take advantage of advancing technology and not as a substitute for incomplete testing before production and deployment.

INTELLIGENCE SUPPORT IS PIVOTAL TO EFFECTIVE TEST AND EVALUATION

Since electronic warfare threat simulators are designed to duplicate the enemy's weapon systems, their designs must be based on accurate intelligence information. A threat simulator based on inaccurate or incomplete intelligence information is virtually worthless and any evaluations based on such a simulator lack credibility. Yet the services are using simulators developed with inaccurate and incomplete intelligence data.

A 1981 Defense Audit Service Report states:

" . . . there was no assurance that the operational tests of Air Force and Navy weapons systems were conducted in a realistic threat environment or that the results of the tests represented true system effectiveness against enemy threats expected to be encountered in combat."

The report cited a lack of intelligence support in the Air Force and the Navy as the primary cause. Our review found many of the same problems. Officials at each of the test ranges we visited complained of known inaccurate and unvalidated threat simulators on their ranges.

For example, an Air Force test facility commander asked the Air Force's Foreign Technology Division to provide intelligence data to support the design of a laboratory threat simulator being developed by the test facility. The data was provided by the Foreign Technology Division and turned over to a contractor. Later, through unofficial sources, the test facility commander found that the Army had an actual enemy system, had contracted with the same contractor to build a working replica, and provided the contractor a far more complete set of specifications than the Foreign Technology Division had given the test facility. Fortunately, the test facility commander was able to amend the

contract and allow the contractor to use the Army specifications. In other cases, however, threat simulators have been built based on inaccurate and incomplete intelligence and have never been validated.

The problem of insufficient intelligence support stems at least partially from the way the Defense Intelligence Agency assigns intelligence analysis responsibilities to the services. The major criterion is to assign responsibility to the service that develops and operates a similar United States system, and not necessarily to the service that the foreign weapon system most seriously threatens. Thus, the Army is assigned primary responsibility for surface-to-air missiles even though they are a major threat to the Air Force.

It is too simplistic to suggest that poor intelligence support is primarily due to inappropriate tasking assignments, although it is certainly one of the major problems. Many other factors are involved in the quality of intelligence support, as numerous internal DOD studies have pointed out. They include

- data too sensitive to disseminate,
- verified data not available,
- foreign weapons too complex and diverse,
- unavailable skilled manpower, and
- misplaced priorities.

Major disagreement over the basic causes exists within the intelligence community. For example, one argument within the Defense Intelligence Agency holds that overly restrictive DOD policies severely limit dissemination of sensitive intelligence data. Counter to that argument, another faction within the Defense Intelligence Agency holds that it is the absence of hard data, not prohibitions on dissemination, that lead to accusations of poor intelligence support.

Intelligence support problems are well known and have been documented by DOD. In an attempt to improve development of threat representative simulators, DOD has a tri-service group called the CROSSBOW-S committee. The committee reviews and coordinates development of threat simulators and gathers the latest Central and Defense Intelligence Agency estimates of the threat. The committee has generated reliable information on several Soviet systems that has been used in developing threat simulators. While the committee's charter and work to date shows good potential, our work and other DOD studies show that intelligence support problems continue to exist.

CONCLUSIONS

The increasing complexity and capability of United States weapon systems as well as the enemy's makes the task of testing and evaluation of weapon systems extremely difficult. Not only must weapon developers build weapons that can defeat the most advanced threats, the developer must test its weapons with test resources that duplicate, to the extent possible, the performance of the enemy's weapons. Only then can the full capabilities and, perhaps more importantly, limitations of our weapons be determined.

Many barriers must be overcome to ensure the successful development and use of electronic warfare threat simulators and aerial targets. Some, like technology, require time and continued effort. Even if a test resource is successfully developed, there may be other limitations on its use that constrain totally realistic testing. Environmental considerations, for example, prevent high powered jammers from being used near civilian communications systems. Safety considerations may also restrict the use of a very low-altitude target. However, we believe improvements are possible through direct management action. These include

- earlier and more detailed test resource planning,
- improved organizational structures,
- increased management emphasis, and
- better intelligence support.

The services have recognized the test resource planning and management problems and are beginning to take action. Most of their efforts, however, identify problems but do not offer plans for corrective action. We are encouraged by their latest efforts, but recognize that they are only first steps and should be followed by definitive action plans.

Although our report focused on the management and use of threat simulators and aerial targets, we believe the problems in planning and management emphasis apply to testing and test resources in general.

While current DOD policy requires specific identification of test resources very early in the planning process, the policy is not being enforced by OSD or the services. Too often, the identification of test resources lacks specificity and timeliness. Consequently, test resource designers and developers do not have adequate time to do their job. In addition, the test agency's ability to test against a full threat spectrum and the consequences of insufficient test resources are not surfaced in the

test and evaluation master plans. Without rigorous early planning, the necessary test resources will not be on the test ranges when the weapon systems need them.

The Navy and the Air Force organizational structures for threat simulator and aerial target development are hindering rather than promoting the timely development of these resources. As a result, direct competition exists between test resources and weapon systems. In addition, fragmented organizational structures result in insufficient coordination, inadequate or duplicate requirements, insufficient support planning, and a lack of cost effectiveness in the acquisition, support, and use of test resources. Threat simulators and aerial targets are a means to evaluate the combat worth of weapon systems--they are not weapons themselves. We believe, therefore, that these resources should neither be considered nor managed as if they were weapons. In addition, we believe certain of the current organizational arrangements create conflicts of interest and should be eliminated.

A DOD-wide need for better management support for electronic warfare and aerial target test resources exists. Test resources do not receive the management emphasis necessary to ensure their timely development.

Although threat simulators depend on accurate and timely intelligence estimates of the threat, many development efforts are hampered by insufficient intelligence support. Major disagreement within the intelligence community exists over the causes of and solutions to known problems. We believe further action is necessary to solve the problems.

AGENCY COMMENTS AND OUR EVALUATION

Representatives from OSD, the Army, Navy, and Air Force provided official oral comments on a draft of this report. They were primarily concerned that we had over generalized in characterizing all testing as inadequate and all test resources as deficient, and in stating that DOD is not committed to a sound test resource program. Our report focuses on the management and use of two types of test resources: electronic warfare threat simulators and aerial targets. We do not intend to generalize our findings to cover all testing and test resource areas. As a result of DOD's concerns, we made changes in the report to avoid such implications. In some cases, such as early planning, our findings cover the overall issue of test resource planning and, thus, our recommendations are to improve all test resource planning.

Overall, DOD believes that its testing program and test resources are adequate, and that it is committed to a continuing, sound test resources program. DOD also stated that our construc-

tive suggestions in threat simulator and aerial target test resources are welcome and that they will continue to emphasize these two areas.

As discussed below, we remain convinced that testing in the two areas we reviewed should be improved.

Complete versus adequate testing

DOD disagreed with our finding that several weapon systems will be fielded without complete testing because existing aerial targets cannot adequately stress the systems' capabilities. They contend that although testing may not be complete, it is adequate. DOD uses a combination of actual tests and simulations to provide the data base for decisions. It remains a fact, however, that existing aerial targets do not replicate the capabilities of threat systems in such important areas as speed, altitude, maneuverability, radar and infrared signatures, and electronic countermeasures capabilities. Laboratory simulations, while giving indications of performance in certain environments, do not demonstrate operational performance as would an actual firing at a representative target. While we believe DOD obtains as much data as it can given current resources, we also believe that the adequacy and availability of test resources needs to be improved so that the completeness and the adequacy of testing can be improved. This, in fact, is the primary message of our report. (See p. 9.)

Air Force management

DOD also disagreed with our finding that Air Force management of threat simulators is fragmented. An Air Force Inspector General report issued in 1979 and an Air Force Systems Command study of test resources issued in 1982 corroborates our audit findings. We have not changed the report. (See p.18.)

Intelligence support

DOD disagreed with our finding of inadequate intelligence support to the test community, including test resource developers. They cite a triservice coordination committee, called CROSSBOW-S, as serving to ensure realistic testing with realistic threat simulators. We are aware that this committee has generated reliable threat information for the test community for some systems. However, as this report points out, a large number of simulator deficiencies still remain and many improvements can be made.

When our audit started, we did not consider intelligence support to be one of the most critical issues. During the audit, however, many members of the test community, from the test ranges to the resource developers, complained about what they perceived

as the genuinely poor quality of support from the intelligence community. They supported their concerns with specific examples. Their complaints were also borne out by Naval Audit Service and Defense Audit Service reports that were very critical of intelligence support to the test community. Since our audit found that no significant changes have occurred, we have not changed our report. (See p. 21.)

DOD also disagreed with our proposal to review all of the issues surrounding intelligence support, citing their disagreements with our findings as support. DOD, however, has not identified the full extent of the problem and unless a critical review of the problem and its causes is undertaken, the poor support will continue. We reaffirm our proposal. (See p. 27.)

Test planning process

DOD disagreed with our proposals to strengthen the quality and usefulness of the test planning process. They agreed that our suggested actions should occur but disagreed that the TEMP is the appropriate vehicle. No other document, however, is prepared or available early enough in the test planning process to address testing and surface issues to higher DOD management. In the absence of any DOD suggested alternative, we have not changed our proposals. (See p 27.)

RECOMMENDATIONS TO THE SECRETARY OF DEFENSE

To improve the planning and management of critical test resources, we recommend that the Secretary of Defense:

- Require the Director, Defense Test and Evaluation to enforce existing requirements for the preparation and approval of weapon system TEMPs before the demonstration/validation and subsequent decision milestones.
- Require predemonstration/validation phase TEMPs to state whether or not test resource requirements are available, and outline what actions have been or need to be taken to develop or acquire those not available. In addition, the effect of being unable to test against the full threat spectrum should be clearly identified.
- Require operational test and evaluation agencies to state in the initial TEMP their ability (or inability) to adequately assess a weapon's operational suitability and effectiveness, given currently available test resources. The adequacy of test resources and the effect of inadequate or incomplete testing should be clearly spelled out.

- Require electronic warfare and aerial target test resource developers to work closely with the weapon developers and test agencies during early test planning to identify the critical test resources needed to fully assess weapon system effectiveness.
- Transfer Navy and Air Force threat simulator and aerial target acquisition responsibility to an organization separate from the weapon systems development activity. The gaining organization should have, as does the Army's threat simulator organization, the independence, authority, responsibility, and funds to ensure the successful acquisition of test resources.
- Establish a joint-service threat simulator and aerial target improvement program to identify, time phase, and prioritize DOD-wide test resource deficiencies; and start development of the resources necessary to match the test capability with current requirements.
- Initiate a review of intelligence support to identify the underlying causes and to solve the problems of inadequate support to the threat simulator development community. In particular, the appropriateness of Defense Intelligence Agency assignments to the service intelligence organizations and the capability of those organizations to support both weapon designers and the test community should be examined and changes made where appropriate.

RECOMMENDATION TO THE CONGRESS

This report shows that major weapon systems are being deployed without the best possible demonstration of their capabilities under combat type conditions. DOD has been giving the Congress reports on the cost, schedule, and performance status of its major weapon systems since 1969. Additionally, annual hearings on weapon systems have continually highlighted weapon performance issues and the need for better test and evaluation, as have many of our reports. Nevertheless, the problems associated with inadequate and incomplete testing continue.

Since improvements in test resources will lead to better testing and thus, to better weapon system performance, we recommend the Congress monitor DOD's implementation of (1) the joint-service aerial target and electronic warfare test resource improvement program and (2) the separation of test resource and weapon system acquisition management in the Navy and the Air Force.

DESCRIPTION OF TERMS USED IN THIS REPORTElectronic warfare

Electronic warfare is any military action involving the use of electromagnetic energy to determine, exploit, reduce, or prevent the enemy's use of the electromagnetic spectrum. The use of electronic warfare includes all levels and areas of combat, including communications, radar systems, and electronic weapons guidance systems. Since most of today's sophisticated weapon systems use, in one way or another, the electromagnetic spectrum, their effectiveness can be severely degraded in an electronic warfare environment.

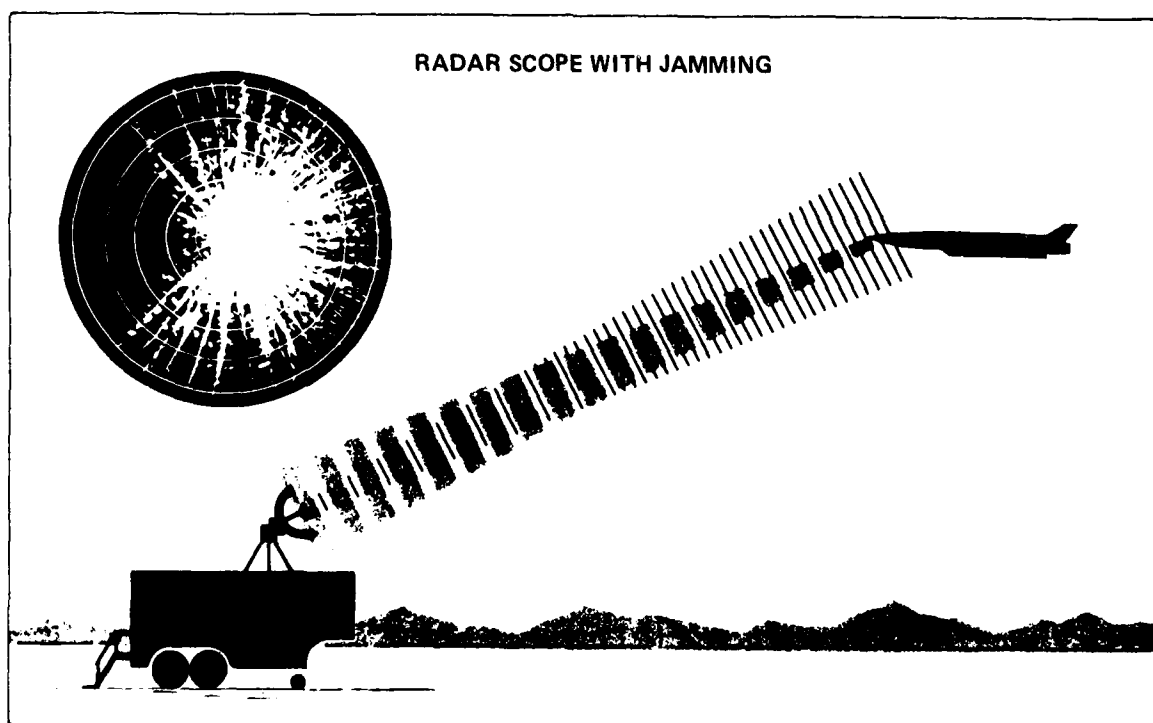
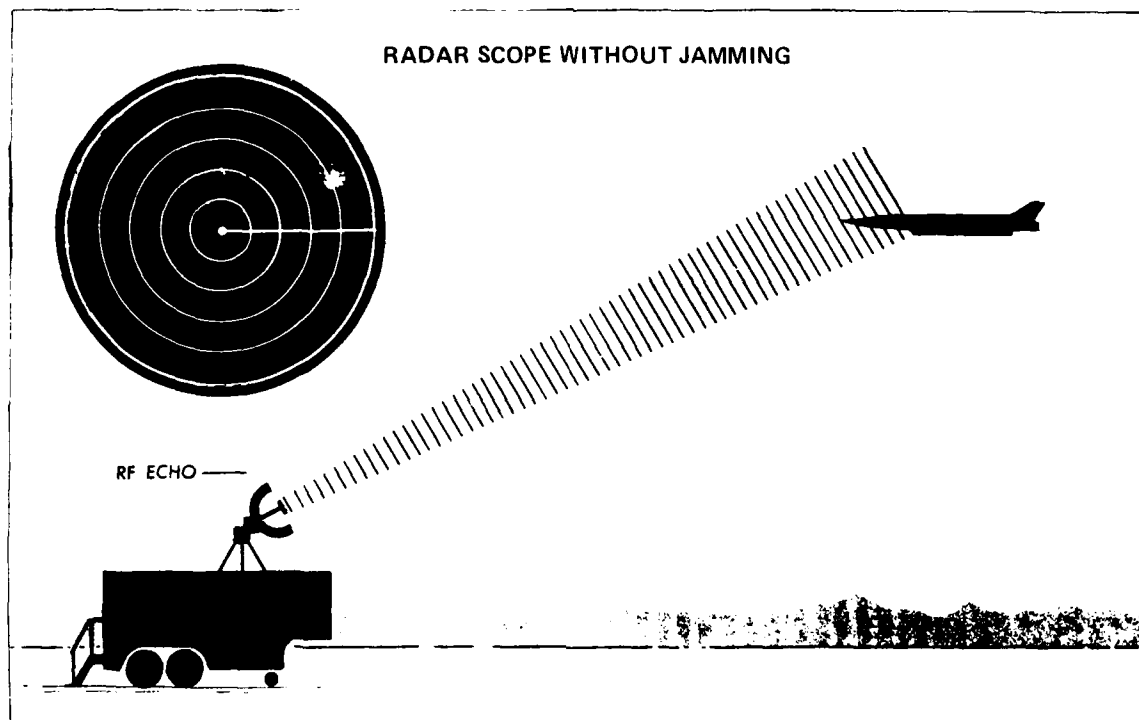
Electronic warfare can be divided into three areas:

1. Electronic warfare support measures--actions taken to search for, intercept, identify, and locate sources of radiated electromagnetic energy.
2. Electronic countermeasures--actions taken to prevent or reduce an enemy's use of the electromagnetic spectrum. The two primary means of electronic countermeasures are jamming and deception. Jamming makes an enemy's electronic equipment unusable. (See fig. 1.). Deception, on the other hand, uses the enemy's electronic equipment to deceive or mislead through manipulation of the enemy's signals.
3. Electronic counter-countermeasures--actions taken to overcome the enemy's use of electronic countermeasures.

Threat simulators

Testing electronic warfare equipment and evaluating its effectiveness requires the use of equipment that simulates, to varying degrees, the enemy's weapons. Threat simulators fall into three categories and range from computer generated signals in a laboratory to actual captured enemy equipment. The categories of threat simulators are emitters, emulators, and replicas.

Emitter--reproduces some or all of the threat systems' transmitter characteristics (e.g., radio frequency, pulse width, power levels, etc.).



(Source: Air Force Pamphlet 51-3, "Electronic Warfare Principles")
Effective Jamming Can Hide A Target And Make A Radar Useless

FIGURE 1

Emulator--in addition to the transmitter, an emulator reproduces some of the threat systems' receiver and/or signal processor characteristics. In some cases, an emulator may be a United States or allied system used as a surrogate or modified to closely resemble the threat. An emulator, like an emitter, is not required to physically resemble the threat system.

Replica--a simulator which possesses all relevant electronic and physical properties of the threat system. (See figs. 2 and 3.)

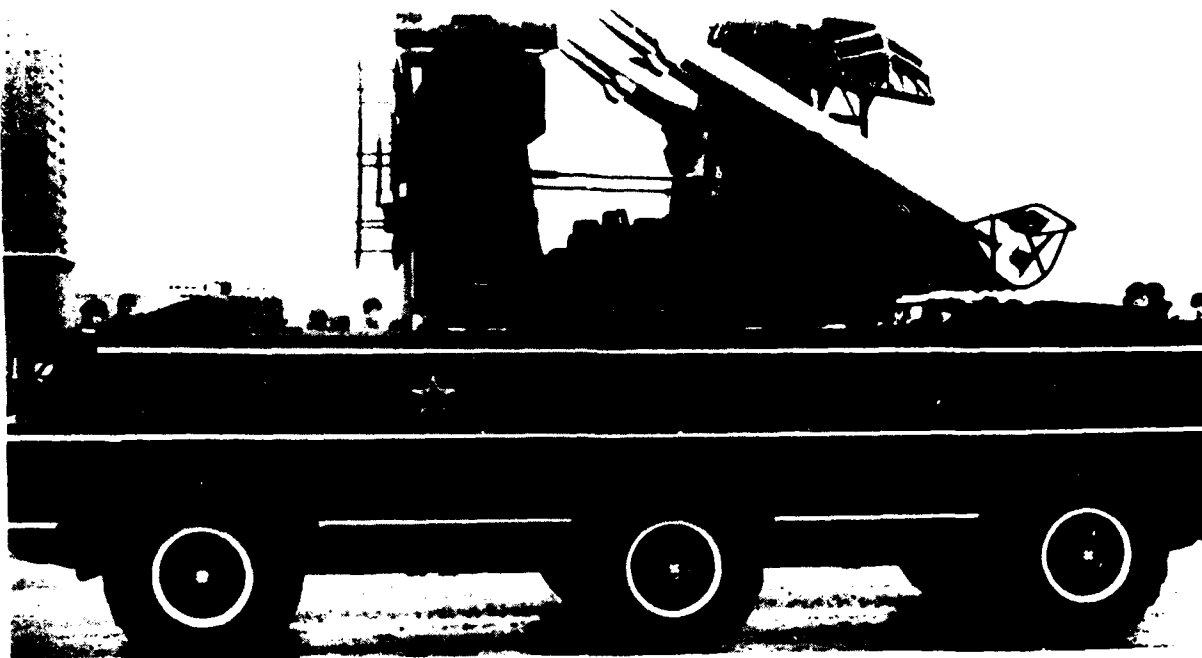
TEST AND EVALUATION

Test and evaluation is conducted throughout the weapon systems acquisition process to identify and reduce development and production risks and to estimate how well a system performs in its intended environment. Test and evaluation is normally divided into three categories.

Development test and evaluation verifies that the weapon meets its technical performance specifications and objectives. Testing is usually done by the weapon system developer.

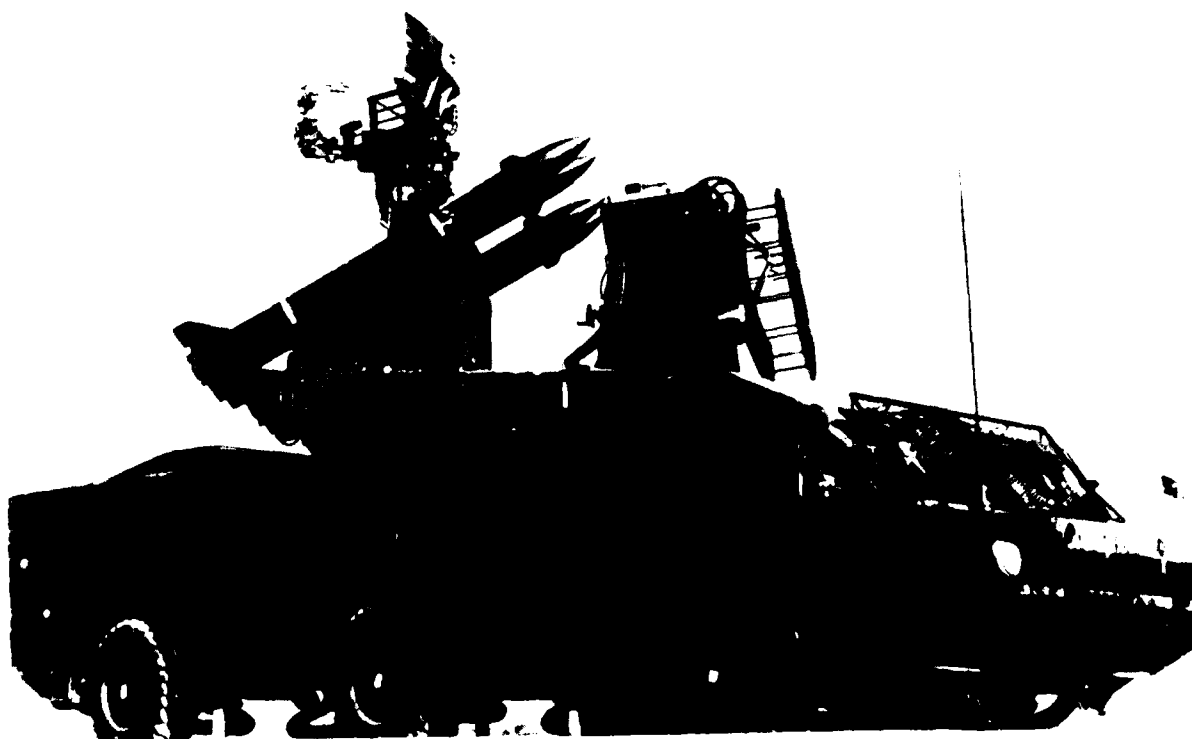
Operational test and evaluation estimates a systems operational suitability and effectiveness. In other words, it determines how well a system can perform its mission and be maintained under operating conditions.

Production acceptance test and evaluation demonstrates that the weapon, after it has been produced, meets the requirements and specifications of the procurement contract.



Source: U.S. Army

Soviet SA-8 (GECKO) Surface-To-Air Missile System
FIGURE 2



Source: U.S. Army

U.S. Army Threat Simulator Of The Soviet SA-8 Surface-To-Air Missile System
FIGURE 3

OUR REPORTS DEALING WITHTEST AND EVALUATION

<u>Title/subject</u>	<u>Report number</u>	<u>Date</u>
Adverse Effects of Large Scale Production of Major Weapons Before Completion of Development and Testing	B-163058	11/19/70
The Importance of Testing and Evaluation in the Acquisition Process for Major Weapon Systems	B-163058	8/07/72
Improvements Needed in Development Testing	B-163058	3/07/74
Review of Testing and Evaluation Policies and Procedures	B-163058	4/18/74
Review of the Adequacy of Department of Defense Test Resources	PSAD-75-84	4/30/75
Effectiveness of Testing of Selected Major Weapon Systems	PSAD-75-74	6/04/75
Does the Department of Defense Have More Test Capacity Than It Needs?	PSAD-76-75	3/01/76
Report to the Secretary of Defense on Operational Testing on the Major Caliber Lightweight Gun	PSAD-77-4	11/05/76
Navy Operational Test and Evaluation: A Valuable Tool Not Fully Utilized	PSAD-78-77	3/29/78
Operational Testing of Air Force Systems Requires Several Improvements	PSAD-78-102	6/02/78

APPENDIX II

APPENDIX II

<u>Title/subject</u>	<u>Report number</u>	<u>Date</u>
Report to the Secretary of Defense on Operational Test and Evaluation of Foreign Built Systems	PSAD-78-131	7/25/78
Report to the Secretary of Defense on Follow-On Operational Test and Evaluation	PSAD-79-1	10/19/78
Need for More Accurate Weapon System Test Results to be Reported to the Congress	PSAD-79-46	3/08/79
Report to the Secretary of Defense on Development Test and Evaluation of Six Systems	PSAD-79-86	6/25/79
Army Operational Test and Evaluation Needs Improvement	C-PSAD-80-2	11/13/79
DOD Information Provided to the Congress on Major Weapon Systems Could be More Complete and Useful	C-PSAD-80-24	5/09/80
Report to the Secretary of Defense on Use of the Design for Testability Concept in the Development and Acquisition of Major Systems	GAO/MASAD-82-38	8/06/82

Note: This listing does not include the numerous individual weapon system reports issued over the years for use by the Congress; many of these reports deal with issues of system performance and involve test and evaluation.

DESCRIPTION OF WEAPON SYSTEMS INCLUDED IN THIS REPORTSINGLE CHANNEL GROUND AND AIRBORNE RADIO SYSTEM

The Very High Frequency Single Channel Ground and Airborne Radio System is the Army's future combat radio. It will be the primary means of communication for armor, artillery, and infantry forces. The radio will be configured for aircraft, vehicular, and manpack applications.

Advanced development began in 1978 and the production award is scheduled for July 1983. The total estimated cost, as of September 1982, is \$531 million for 38,000 radios.

TACTICAL ARMY COMMUNICATIONS JAMMING SYSTEM

The Tactical Army Communications Jamming System is a ground-mobile communications jammer used at division and corps levels. The system can jam enemy tactical communications and digital (secure) voice and data links. The system is in production and is scheduled for followup operational testing during the third quarter, fiscal year 1983. Total estimated program cost as of September 1982, is \$240.3 million.

PATRIOT

The Patriot Air Defense Missile System (formerly the SAM-D) development program began in 1965. Its mission is to provide low- and medium-altitude air defense coverage to the field Army. The Patriot will replace the Hawk and the Nike Hercules weapon systems.

The system was approved for limited production in September 1980. The first Patriot battalion was activated in May 1982. As of September 1982, total program cost is estimated to be \$11.3 billion.

HIGH SPEED ANTI-RADIATION MISSILE

The High Speed Anti-Radiation Missile is being developed jointly by the Navy and the Air Force to give aircraft performing surface attack missions a better chance of penetrating enemy radar defenses by destroying or suppressing land- and sea-based radars of enemy air defense systems.

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The missile is in limited production and undergoing operational test and evaluation. As of September 1982, the Air Force's estimated total program cost was \$4.7 billion. The Navy's estimated total program cost was \$3.1 billion for a total joint program cost of \$7.8 billion.

AN/ALQ-126B

The AN/ALQ-126B Defensive Electronic Countermeasures Set is a follow-on to the AN/ALQ-126A and was developed to increase protection for naval aircraft against modern, diversified radar controlled weapon systems such as land- and sea-based surface-to-air missile systems. As of September 1982 the total program cost was estimated at \$725 million.

The AN/ALQ-126B completed its operational evaluation in April 1982.

PHOENIX (AIM-54C)

The Phoenix is an all-weather air-to-air missile to counter high- and low-altitude aircraft and missiles. It has the capability to engage multiple targets, and operate at both visual and beyond visual ranges. The F-14A is the only aircraft capable of carrying the Phoenix missile.

The "C" model development program began in 1976 to provide increased lethality, electronic counter-countermeasures performance, high- and low-altitude performance, and improved reliability and maintainability.

Full-scale production is expected to begin shortly. A total of 2,680 missiles are scheduled to be built through fiscal year 1988. As of June 30, 1982, the Navy estimated that the total program cost would be \$3.1 billion.

B-52 G/H OFFENSIVE AVIONICS SYSTEM

The B-52 G/H Offensive Avionics System is intended to provide improved reliability and maintainability to the B-52 G/H bombing and navigation system which is becoming logistically unsupportable. It allows the B-52 G/H to carry, align, target, and launch the AGM-86B Air-Launched Cruise Missile. The program, started in 1976, was approved for production in July 1979 but did not start development test and evaluation and initial operational

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test and evaluation until June 1980. That phase of testing was completed in September 1982. A separate phase of testing, called Integrated Weapon System testing that involves the B-52, the Air-Launched Cruise Missile, and the Short-Range Attack Missile, began in October 1981, and will continue until December 1983. Initial operational capability was achieved in December 1982. Total projected program costs are \$3.6 billion (as of September 1982).

F-16 MULTINATIONAL STAGED IMPROVEMENT PROGRAM

The F-16 Multinational Staged Improvement Program is a three stage approach to upgrade the capabilities of the F-16 multimission fighter aircraft. Extending from 1980 to the 1990s, the program will incorporate improvements in weaponry, communications, navigation, and sensors, at a projected cost of \$3.9 billion for the first 144 aircraft (as of September 1982).

Stage I of the program is underway, fitting new aircraft with structural, wiring, and cooling system changes to support future growth. Stage II has begun with contractor testing, and is expected to continue until 1984 with primarily avionics, radar, and cockpit changes. Stage III, scheduled to extend several years further into the future, will involve progressive integration of such advanced systems as the AMRAAM, the Airborne Self-Protection Jammer, the Precision Location Strike System, and the Low-Altitude Navigation and Targeting Infrared System for Night.

EF-111A

The EF-111A Tactical Jamming System is an Air Force F-111A aircraft modified to carry radar jamming systems. It will be used to protect friendly aircraft by jamming enemy early warning, acquisition, and ground control intercept radars. The EF-111A is replacing the EB-66 weapon system which has been retired.

Full-scale production began in March 1979. As of June 30, 1982, the Air Force estimated that total program costs would be \$1.5 billion for 42 aircraft.

LOCATIONS VISITED

Office of the secretary of Defense:

Office of the Under Secretary
of Defense, Research and Engineering
Washington, D.C.

Assistant Deputy Under Secretary for Acquisition
Director, Major Systems Acquisition
Washington, D.C.

Deputy Under Secretary (C3I)
Director, Electronic Warfare and
C3 Countermeasures
Washington, D.C.

Director, Defense Test and Evaluation, Washington, D.C.

Defense Audit Agency, Washington, D.C.

Defense Science Board, Washington, D.C.

Defense Intelligence Agency, Washington, D.C.

Department of the Army:

Deputy Chief of Staff for Operations and Plans
Washington, D.C.

Deputy Chief of Staff for Research,
Development, and Acquisition
Washington, D.C.

Army Audit Agency, Washington, D.C.

U.S. Army Operational Test and Evaluation Agency
Falls Church, Virginia

White Sands Missile Range
White Sands, New Mexico

Office of Missile Electronic Warfare
White Sands, New Mexico

Army Defense School
ADATS Program Office
Fort Bliss, Texas

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Electronic Proving Ground
Fort Huachuca, Arizona

U.S. Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland

Department of the Navy:

Director, Command and Control
Electronic Warfare Division
Washington, D.C.

Office of Research, Development, Test
and Evaluation
Washington, D.C.

Naval Air Systems Command, Washington, D.C.
F-14/Phoenix Project Office
Defense Suppression Project Office
Reconnaissance, Electronic Warfare,
Special Operations, and Naval
Intelligence (REWSON) Project Office
Assistant Commander for Test and Evaluation

Naval Electronic Systems Command, Washington, D.C.
REWSON Systems Project Office

Naval Audit Service, Washington, D.C.

Headquarters, Navy Operational
Test and Evaluation Force
Norfolk, Virginia

Deputy Commander, Operational
Test and Evaluation Force
San Diego, California

Naval Weapons Center
China Lake, California

Air Test and Evaluation Squadron Five
China Lake, California

Pacific Missile Test Center
Point Mugu, California

Air Test and Evaluation Squadron Four
Point Mugu, California

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U.S. Pacific Fleet, San Diego, California
Headquarters, Surface Forces
Headquarters, Naval Air Force

Department of the Air Force:

Deputy Chief of Staff, Plans and Operations
Washington, D.C.

Deputy Chief of Staff, Research Development
and Acquisition
Washington, D.C.

Air Force Audit Agency, Washington, D.C.

Air Force Test and Evaluation Center
Albuquerque, New Mexico

Headquarters, Strategic Air Command
Offutt Air Force Base, Nebraska

Headquarters, Tactical Air Command
Langley, Air Force Base, Virginia

Aeronautical Systems Division
Wright-Patterson Air Force Base, Ohio

Armament Division
Eglin Air Force Base, Florida

Air Force Electronic Warfare Evaluation Simulator,
Fort Worth, Texas

Joint Electronic Warfare Center
San Antonio, Texas

Air Defense Weapons Center
Tyndall Air Force Base, Florida

Other:

American Defense Preparedness Association, Washington, D.C.

National Security Industrial Association, Washington, D.C.

General Dynamics Convair Division, San Diego, California

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